25th INTERNATIONAL CONFERENCE ON SUPERSYMMETRY AND THE UNIFICATION OF FUNDAMENTAL INTERACTIONS (SUSY17)

Monday 11 December 2017 - Friday 15 December 2017

TIFR, Mumbai 40005

Book of abstracts

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Search for Standard Model Higgs production in association with top quark pairs using 13 TeV CMS data.

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After the discovery of a new boson of mass 125 GeV, one of the main goals of the LHC is to precisely measure its properties. Within the current experimental uncertainties, the properties of this boson are compatible with the expectation for the standard model (SM) Higgs boson. However, due to lack of sufficient data, some of the properties of this particle are yet to be measured. The Yukawa coupling between the Higgs boson and the top quark is one such crucially important property. Many beyond SM theories predict deviations of this coupling from SM value as evidence for new physics. Higgs production in association with top quarks (ttH) allows a direct measurement of this coupling. In this talk, I would be giving an overview of the search for top quark associated SM Higgs boson production using 13 TeV data collected by CMS experiment at the LHC.

3

Use of soft tracks in compressed SUSY

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Compressed spectra remains a natural hideout for many beyond standard model scenarios. The lack of visible energy in the final state results in a much weaker bound on the new physics (NP) particles. The final state topology is simple, consisting of a single hard jet and missing energy. However, the information at hand is minimalistic in nature. Therefore, it is hard to increase the signal purity and sensitivity with the traditional observables. In this light, the inclusion of soft tracks, which carries the information of particle multiplicities in an event can increase the signal sensitivity by many orders. We will present our results in a toy example to start with and then apply this idea in compressed SUSY scenarios.

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Closing in on Wino dark matter at the LHC

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The Minimal Supersymmetric Standard Model (MSSM) predicts the existence of a total of four neutralinos, the lightest of which is one of the strongest cold dark matter (DM) candidates. The nature of this neutralino DM depends on the relative sizes of the bino, wino and higgsino mass parameters in the neutralino mass matrix. At the LHC, the trilepton channel, which is one of the most important modes for analysing certain Standard Model (SM) processes as well as for probing physics beyond the SM, has been adapted for the supersymmetric DM search also. However, the assumptions underlying the masses of the DM and of the next-to-lightest neutralino and the decaying chargino, along with the selection criteria defined for events with three leptons and missing transverse momentum, are inspired mainly by the bino-like DM scenario in the MSSM. Such a DM is motivated by the relic abundance measurements and some recent astroparticle observations, and, for sufficiently large accumulated luminosity, the trilepton probe has been shown to carry promise for certain MSSM parameter space regions. We have analyzed the scope of this search channel in the context of the wino-like DM, for which this topology can in fact be sensitive to two different processes: (i) lightest-chargino plus heavy neutralino production, and (ii) lightest-neutralino plus heavy chargino production. We have studied the interplay between the two modes, and shown that slight optimisation of this search channel may make another very interesting MSSM DM scenario accessible at the LHC Run-II. We have further established that this channel can help fix the sign of the mu-parameter for certain specific configurations of the other parameters of the model.

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Signatures of the Type-I 2HDM at the LHC

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One of the simplest extensions of the Standard Model (SM) is the 2-Higgs-doublet model (2HDM), which predicts the existence of two neutral Higgs bosons and a charged pair, H+-, in addition to one that mimics the observed ~125 GeV Higgs boson. At the LHC, as is the case for the SM Higgs boson, gluon fusion is generally considered to be the dominant mode for the resonant production of the additional neutral Higgs bosons also. They can moreover be produced in pairs, with each other and with the ~125 GeV one, in the decays of a heavier Higgs boson, itself produced resonantly. However, we have established in a recent analysis that, when the combined mass of a pair of the new scalar and pseudoscalar, h and A, is smaller than that of the Z boson, their electroweak production via a resonant Z boson can have a substantial cross section in certain regions of the Type-I 2HDM parameter space. In these regions, it is further possible for (1) h to be highly fermiophobic, with a large branching ratio into a pair of photons, and (2) the H+- to decay dominantly into Wh. Following these observations, we further analysed the Type-I 2HDM parameter space, after performing its numerical scanning, with the mass of the heavier of the scalars, H, fixed to 125 GeV, and identifying regions with enhanced decays of H+- into W and a fermiophobic h. We found that the total cross section of the □process pp -> hH+- -> W□ + 4 photons can reach up to O(100 fb) at the LHC Run-II. While either of these two signatures would serve as a clear indication of physics beyond the SM, their dual observation could be an important step towards establishing the Type-I 2HDM as the underlying model of new physics.

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A New Class of de Sitter Vacua in Type IIB Large Volume Compactifications

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We construct a new class of metastable de Sitter vacua of flux compactifications of type IIB string theory. These solutions provide a natural extension of the `Large Volume Scenario' anti-de Sitter vacua, and can analogously be realised at parametrically large volume and weak string coupling, using standard N=1 supergravity. For these vacua, a positive vacuum energy is achieved from the inclusion of a small amount of flux-induced supersymmetry breaking in the complex structure and axio-dilaton sector, and no additional `uplift' contribution (e.g. from anti-branes) is required. After discussing some general properties of these vacua, we provide a recipe for constructing de Sitter vacua on a given compactification manifold, and give an explicit example of a de Sitter vacuum for the compactification on the Calabi-Yau orientifold realised in CP^4_{11169}. These solutions have intriguing implications for phenomenology, predicting no superpartners in the spectrum below 50 TeV, and no WIMP dark matter.

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Searching for Squeezed Spectra

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There are a variety of new physics scenarios, including the Minimal Supersymmetric Standard Model, in which dark matter interactions with Standard Model matter can be mediated by new charged particles. We investigate the interesting phenomenology which arises if the dark matter and the new charged particles are nearly degenerate in mass. In particular, we study enhanced signals at dark matter direct detection experiments, a broadening of the thermal relic parameter space resulting from co-annihilation, and strategies for probing these scenarios at colliders. We find that, although scenarios with squeezed spectra have thus far been challenging to probe at the LHC, they providing for interesting cosmology which can by studied with an extended run at the LHC and with new direct detection experiments.

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Inflation to Structures: EFT all the way

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We investigate for an Effective Field Theory (EFT) framework that can consistently explain inflation to Large Scale Structures (LSS). With the development of the construction algorithm of EFT, we arrive at a properly truncated action for the entire scenario. Using this, we compute the two-point correlation function for quantum fluctuations from Goldstone modes and related inflationary observables in terms of coefficients of relevant EFT operators, which we constrain using Planck 2015 data. We then carry forward this primordial power spectrum with the same set of EFT parameters to explain the linear and non-linear regimes of LSS by loop-calculations of the matter overdensity two-point function. For comparative analysis, we make use of two widely accepted transfer functions, namely, BBKS and Eisenstein-Hu, thereby making the analysis robust. We finally corroborate our results with LSS data from SDSS-DR7 and WiggleZ. The analysis thus results in a consistent, model-independent EFT framework for inflation to structures.

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Search for sleptons and charginos at CMS

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Searches for supersymmetry are presented that target the direct slepton or chargino pair production. The analyses exploit the final states with two leptons (e, mu or tau) of opposite charge and significant missing transverse momentum. The results are based on a data set of proton-proton collisions, recorded by the CMS experiment at a center-of-mass energy of 13 TeV and corresponding to an integrated luminosity of 36 fb-1.

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Non-Abelian Vector Boson Dark Matter, its Unified Route and signatures at the LHC

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We study possible manifestations of non-abelian vector boson dark matter that can be accommodated in an extension of SM by $SU(2)$ gauge symmetry. One of the possibilities have been explored in gory details where an additional global $U(1)$ has been imposed, which eventually breaks to a remnant $(-1)^L$ with $L=T_{3N}+S$, thus stabilising the lightest of the neutral vector gauge bosons under additional $SU(2)$. Effective t-channel annihilation and s-channel direct search process makes this model long lived from ever growing direct search razor. By embedding this model in $E(6)$, we show that it is possible to achieve unification via consistent intermediate symmetries. We also explore signatures at LHC in multilepton final state which might be more sensitive than direct search. In an ongoing work, we study alternate prescription of stabilisation of such a vector boson DM, which offers altogether distinct phenomenology with multipartite DM framework.

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Radiactive and Electroweak Penguin B Decays at Belle II

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The radiactive and electroweak penguin B decays proceed via one-loop diagram
and are sensitive to new physics. Recently LHCb reported two anomalies in $B \to K^{(*)} \ell^+ \ell^-$ decays; One is the angular observables P5' with 3.4σ significance which suggests $C_9^{\rm NP} = -1$, and the other is lepton flavor non-universality in low q^2 region. We will report the prospects for the test of anomalies at Belle II, especially inclusive b->sl+l- processes and electron modes at high q^2 region allows comprehensive test which is hard at hadron colliders. We also present the prospects of other processes which are sensitive to new physics, such as $b \to s \gamma$, $b \to d \gamma$, $b \to s \nu \bar{\nu}$.

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Prospects of semi-leptonic B decays and CKM parameters from B decays with the Belle II experiment

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A range of flavour physics observables show tensions with their corresponding Standard Model expectations: measurements of semi-leptonic flavour-changing neutral current processes and ratios of semi-leptonic tree-level decays involving τ and light leptons show both deviations of the order of four standard deviations. If confirmed, both would be an intriguing sign of new physics. We present in this talk the current experimental situation of such processes and estimate how the future super-flavour factory Belle II will be able to influence the present tensions with the standard model expectations. In addition the future sensitivity of the tree-level CKM parameters |Vub| and |Vcb| is discussed.

15

Dark Sector Physics with Belle II

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The next-generation B-factory experiment Belle II at SuperKEKB will start physics data taking in 2018. SuperKEKB is an asymmetric e+e- collider that will operate with 40 times of the instantaneous luminosity of its predecessor, KEKB. Belle II/SuperKEKB aims to collect 50 times more data compared to Belle/KEKB.

Belle II offers the possibility to search for a large variety of dark sector particles in the GeV mass range. The project is complementary to LHC and dedicated low energy experiments. These searches will profit both from the very large data set that will be acquired by the Belle II experiment, and from the specifically designed triggers during the early running stage of Belle II. This talk will review planned dark sector searches with a focus on the discovery potential of the first data.

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2-, 3-, and 4-body stop decays with gravitino LSP

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In scenarios of the Minimal Supersymmetric Standard Model where the gravitino is the LSP and the Stop is the NLSP, the Stop could have a long life-time, which makes it a quasi-stable particle that require special strategies to be searched at hadron colliders. We calculate the lifetime for the stop decay in different regions of parameter space where the different N-body modes are open, namely for the decay modes: stop⟶ top+gravitino (2-body), stop ⟶ b+W +gravitino (3-body) and stop ⟶ b+l+nu+gravitino (4-body). The calculation presented here employs an appropriate helicity formalism suited for dealing with the massive particles that arise in N=1 Supergravity. Implications for collider physics and cosmology are discussed in this talk.

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High energy neutrinos

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I will describe implications of IceCube neutrino data for an assortment of particle physics including (a subset of) new neutrino interactions, sterile neutrinos, dark matter and Lorentz violation.

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Entangled de Sitter from Axionic Bell pair: An analysis using Bunch Davies and α vacuum

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In this work, we study the quantum entanglement and compute entanglement entropy in $3+1$ dimensional de Sitter space for a bipartite quantum field theory driven by axion originating from Type IIB string theory. We also consider the initial choice of vaccum to be Bunch Davies and α vacuum state. We then, derive the expressions for density matrix by tracing over the exterior region. This allows us to compute entanglement entropy and Re´nyi entropy in 3+1 dimensions. Further we quantify the UV finite contribution of entanglement entropy which contain the physics of long range quantum correlations of our expanding universe. Finally, our analysis compliments the necessary condition for the violation of Bell's inequality in primordial cosmology due to the non vanishing entanglement entropy for axionic Bell pair.

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Two component WIMP-FImP dark matter model with singlet fermion, scalar and pseudo scalar

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We explore a two component dark matter model with a fermion and a scalar. In this scenario the Standard Model (SM) is extended by a fermion, a scalar and an additional pseudo scalar. The fermionic component is assumed to have a global U(1)DM and interacts with the pseudo scalar via Yukawa interaction while a Z2 symmetry is imposed on the other component -- the scalar. These ensure the stability of both the dark matter components. Although the Lagrangian of the present model is CP conserving, however the CP symmetry breaks spontaneously when the pseudo scalar acquires a vacuum expectation value (VEV). The scalar component of the dark matter in the present model also develops a VEV on spontaneous breaking of the Z2 symmetry. Thus the various interactions of the dark sector and the SM sector are progressed through the mixing of the SM like Higgs boson, the pseudo scalar Higgs like boson and the singlet scalar boson. We show that the observed gamma ray excess from the Galactic Centre, self-interaction of dark matter from colliding clusters as well as the 3.55 keV X-ray line from Perseus, Andromeda etc. can be simultaneously explained in the present two component dark matter model.

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False vacuum decay in gauge theory

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The decay rate of the false vacuum consists of an exponential suppression factor and a pre-factor. The pre-factor is important for a precise determination of the decay rate, and is obtained by calculating the one-loop correction to the action. A numerical method for it has been known, but there are several difficulties when the gauge bosons are involved; the gauge invariance is not clear and the correct treatment of the gauge zero mode is not known.
In a U(1) gauge theory, we propose a method that can overcome these, and provide simplified formulae for the decay rate that are explicitly gauge invariant.

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A Perturbative RS I Cosmological Phase Transition

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We identify a class of Randall-Sundrum type models with a successful first order cosmological phase transition during which a 5D dual of approximate conformal symmetry is spontaneously broken. Our focus is on soft-wall models that naturally realize a light radion/dilaton and suppressed dynamical contribution to the cosmological constant. We discuss phenomenology of the phase transition after developing a theoretical and numerical analysis of these models both at zero and finite temperature. We demonstrate a model with a TeV-Planck hierarchy and with a successful cosmological phase transition where the UV value of the curvature corresponds, via AdS/CFT, to an N of 20, where 5D gravity is expected to be firmly in the perturbative regime.

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LHC Dark Matter Signals from Vector Resonances and Top Partners

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Extensions of the Standard Model which address the hierarchy problem and dark matter (DM) often contain top partners and additional resonances at the TeV scale. We explore the phenomenology of a simplified effective model with a vector resonance Z′Z′, a fermionic vector-like coloured partner of the top quark T′T′ as well as a scalar DM candidate ϕϕ and provide publicly available implementations in CalcHEP and MadGraph. We study the pp⟶Z′⟶T′\bar{T'}⟶tt¯ϕϕ process at the LHC and find that it plays an important role in addition to the T′\bar{T'} production via strong interactions. It turns out that the presence of the Z′Z′ can provide a dominant contribution to the tt¯+Emiss_{T} signature without conflicting with existing bounds from Z′Z′ searches in di-jet and di-lepton final states. We find that through this process, the LHC is already probing DM masses up to about 900 GeV and top partner masses up to about 1.5 TeV, thus exceeding the current bounds from QCD production alone almost by a factor of two for both particles.

25

A Unified Model of Quarks and Leptons with a Universal Texture Zero

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We show that a universal texture zero in the (1,1) position of all fermionic mass matrices, including heavy right-handed Majorana neutrinos driving a type-I see-saw mechanism, can lead to a viable spectrum of mass, mixing and CP violation for both quarks and leptons. We model this texture zero with a non-Abelian discrete family symmetry that can easily be embedded in a SUSY grand unified framework, and discuss the details of the phenomenology after electroweak and family symmetry breaking. We provide an explicit numerical fit to the available data and obtain excellent agreement with the 18 observables in the charged fermion and neutrino sectors with just 9 free parameters, assuming the observables are radiatively corrected to the GUT scale in the context of the MSSM. We further show that the vacua of our new scalar familon fields are readily aligned (in a SUSY framework) along desired directions in family space, and also demonstrate discrete gauge anomaly freedom at the relevant scale of our effective theory.

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Non-standard Annihilation Processes in the Scalar Dark Matter Models

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Minimal scalar Z_2 Higgs portal dark matter model is increasingly in tension with recent results form direct detection experiments like LUX and XENON. In this talk we will discuss strategies which can ease the considerable constraint from these experiments on scalar dark matter. We will consider the possibility of enlarging the stabilizing symmetry to Z_3, incorporating multipartite features in the dark sector and generalizing to novel n(>2) -> 2 annihilation processes. We demonstrate that an interplay of annihilation, co-annihilation, semi-annihilation and resonant semi-annihilation processes considerably relax constraints from present and proposed direct detection experiments while simultaneously saturating observed relic density for GeV scale dark matter. While generalizing to n -> 2 "assisted annihilation" processes, result in viable dark matter in the MeV/keV scale. We discuss some astrophysical and cosmological consequences on such light dark matter scenario.

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Anomalies in B Decays and Possible explanation

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Enhancement in decays B -> D tau nu and B -> D* tau nu in the context of d_R squark/ lepto-quark exchange is examined. Explanation of anomalies in B -> K mu mu and K* mu mu in the same context are also addressed. Tension between various constraints from data are presented. Possible alternate suggestions to resolve the anomalies are also presented.

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The Vev Flip-Flop: Impact of Cosmological Phase Transitions on the Dark Matter Abundance

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We argue that phase transitions in the Early Universe may have a dramatic impact on dark matter (DM) production. For instance the symmetry stabilizing DM could be temporarily broken, leading to substantial depletion. Moreover, the evolution of scalar vacuum expectation values through a phase transition can open or close production channels. We present toy models that illustrate these novel phenomena and we study them using detailed simulations, employing methods of thermal quantum field theory. We comment on implications for gravitational wave observations.

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$ h \to b \bar b \gamma $ at the LHC and an $ e^+ e^- $ collider

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In the light of the 125 GeV Higgs discovery at the Large Hadron Collider (LHC), one of the primary goals of the LHC and possible future colliders is to understand its interactions more precisely. Here we have studied the $h b \bar b \gamma$ effective interaction terms arising out of gauge invariant dimension six operators in a model independent setting, as a potential source of new physics. The collider signatures of such interactions have been analysed in the context of 14 TeV LHC and and a future $e^+ e^-$ machine. We have considered the bounds coming from the existing collider and other low energy experimental data in order to derive constraints on the potential new physics couplings.

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Complete superspace classification of three-dimensional Chern-Simons-matter theories coupled to supergravity

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I will present a method for classifying all possible gauge groups for a scalar multiplet allowed by the algebras of global and local N≤8 extended supersymmetry in three dimensions. A special focus lies on the issue of supersymmetry enhancement. For the corresponding topologically massive gravity with negative cosmological constant I will show how the mass of the graviton is determined algebraically in terms of N and the possible gauge couplings.

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Searches for dark-sector low-mass bosons at BaBar

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We report on the latest searches for low-mass states predicted in several dark-sector models, performed with the data collected by the BaBar detector at the PEP-II e+e- collider.
In particular, we search for single-photon events in 53 fb−1 of e+e− collision data. We look for events with a single high-energy photon and a large missing momentum and energy, consistent with production of a spin-1 particle A' through the process e+e- -> gamma A', A' -> invisible. Such particles, referred to as "dark photons", are motivated by theories applying a U(1) gauge symmetry to dark matter. We find no evidence for such processes and set 90% confidence level upper limits on the coupling strength of A' to e+e- for a dark photon with a mass lower than 8 GeV. In particular, our limits exclude the values of the A' coupling suggested by the dark-photon interpretation of the muon (g-2) anomaly, as well as a broad range of parameters.
We also present a search for a new muonic dark force mediated by a gauge boson (Z') coupling only to the second and third lepton families. The existence of the Z' boson is probed in e+e− -> mu+ mu- Z', Z' -> mu+mu- events, by using about 470 fb-1 of data collected at a center-of-mass energy of about 10.58 GeV. No significant signal is observed. Limits on dark-sector coupling constants are derived, improving the current constraints to the allowed parameter space.

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Electroweak vacuum stability in presence of singlet scalar dark matter in TeV scale seesaw model

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We consider singlet extensions of the standard model, both in the fermion and the scalar sector, to account for the generation of neutrino mass at the TeV scale and the existence of dark matter respectively.
For the neutrino sector we consider models with extra singlet fermions which can generate neutrino mass via the so called inverse seesaw whereas a singlet scalar is introduced as the candidate for dark matter. We show that although these two sectors are disconnected at low energy, the coupling constants of both the sectors get correlated at high energy scale by the constraints coming from the perturbativity and stability/metastability of the electroweak vacuum. The singlet fermions try to destabilize the electroweak vacuum while the singlet scalar aids the stability. As an upshot, the electroweak vacuum may attain absolute stability even up to the Planck scale for suitable values of the parameters. We delineate the parameter space for the singlet fermion and the scalar couplings for which the electroweak vacuum remains stable/metastable and at the same time giving the correct relic density and neutrino masses and mixing angles as observed.

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Charged Inflatons in Supergravity

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We analyze the possibility of the inflaton to be charged under a gauge group in a supergravity context. The simplest example with a charged inflaton multiplet under a U(1) gauge symmetry is explored. In addition, we provide a more realistic GUT model for charged inflaton. The effective scalar potential for the inflaton is found to be
similar to the “new chaotic inflation” scenario.

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Multipartite Dark Matter and Phenomenology.

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Single component dark matter frameworks have been studied extensively in terms of scalar, fermion or vector boson dark matter. In this talk, we explore possibilities of extending simple scalar and fermion dark matter frameworks to incorporate multipartite features, particularly highlighting the interactions between two dark matter components effecting the freeze out of the individual dark matter components, and how that alleviates the ever increasing direct search bounds. To be specific, we consider two situations: (i) A two component scalar dark matter framework with $Z_2\times Z_2'$ and $Z_3\times Z_3'$ stabilising symmetry and (ii) A two component scalar-fermion dark matter with the same discrete symmetry. We also indicate features of collider signatures at LHC for such multipartite dark matter framework and constraints from vacuum stability in this regard.

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A Brief Overview of Next-to-Minimal Composite Higgs Model

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Composite Higgs models, where the Higgs boson emerges as a pseudo Nambu-Goldstone boson (pNGB) of some strongly interacting sector, are well motivated as a non-SUSY approach to solve the Hierarchy problem of Standard Model (SM). In this talk I will describe the next-to-minimal composite Higgs model with a SO(6)/SO(5) coset, whose pNGB sector includes a SM singlet in addition to the usual Higgs doublet. I will explain the consequences of the singlet receiving a vacuum expectation value and thereby leading to mass mixing between the Higgs and the singlet scalar. This can provide a handle to accommodate heavier resonances (top-partners) for same compositeness scale as compared to the minimal model, thus relaxing the tension with the direct LHC bounds. The main phenomenological consequences of this setup comprising of sizable deviations of the Higgs couplings from their SM predictions will also be discussed.

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Constraining Warm Inflation with CMB data

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Warm inflation is an exciting alternative to the standard cold inflation scenario where the inflating universe had a warm exit to the radiation dominated era rather than a supercold exit to a reheating phase (in the standard cold inflation). The constraints from Planck satellite has ruled out most of the text book potentials such as quartic potential in the standard scenario. In this work, we constrain the model parameters for warm inflation from Planck 2015 data. We have worked with the quartic potential in the warm inflation scenario and have shown this potential is well alive (w.r.t the Planck constraints) in the warm scenario. In addition, the reheating era can be optimised by varying the number of e-folds of inflation. Best fit values for the model parameters are estimated with and without the contribution to fluctuation from thermal excitation.(arXiv:1710.10008 [astro-ph.CO])

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A Lepton-specific Universal Seesaw Model with Left-Right Symmetry

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We propose a left-right symmetric framework with universal seesaw mechanism for the generation of masses of the Standard Model quarks and leptons. Heavy vector-like singlet quarks and leptons are required for generation of Standard Model-like quark and lepton masses through seesaw mechanism. A softly broken Z2 symmetry distinguishes the lepton sector and the quark sector of the model. This leads to the presence of some lepton-specific interactions that can produce unique collider signatures which can be explored at the current Large Hadron Collider run and future e+e- and e p colliders.

40

Revisiting flavour constraints on high-scale SUSY

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We present the results of a detailed analysis of various low-energy flavour-violating observables within supersymmetry extensions of the SM, under the assumption of motivated flavour-symmetry breaking structures.

In particular, we study the effects in the MSSM supplemented by the hypotheses of: i) MFV, ii) U(2) flavour symmetry, iii) disoriented A-terms, iv) U(1) Frogatt-Nielsen. We analyse in particular B-Bbar and K-Kbar mixing amplitudes, and various b⟶s and s⟶d rare-decay observables.

By comparing the results obtained in different flavour-breaking schemes, we estimate the sensitivity of future low-energy precision measurements to different realisations of the MSSM. We demonstrate in particular the discovery power of low-energy measurements to heavy-scale scenarios that cannot be directly accessed at the LHC. Finally, in light of the recent, so-called, B-physics anomalies, we investigate the possibility of accommodating some of them in specific realisations of the MSSM.

41

Unique collider signatures of quintuplets in a left right symmetric model with minimal dark matter

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Left-right symmetric models can address several phenomenon
which are not well understood in the Standard Model. In
this framework we consider a minimal fermionic quintuplet, whose
neutral component can be a viable dark matter. The charged
components of the quintuplet can be pair produced at hadronic colliders and photon fusion production has a very significant contribution there. The decay of the charged components give spectacular leptonic signatures. In this talk I will discuss the production and various decay modes of the quintuplet fermions, giving rise to the same sign multilepton signatures at 13 TeV LHC. It is possible to reduce the backgrounds by multiple selections at detector level. Overall there is a good prospect for exclusion and discovery at 13 TeV LHC.

42

Generalized $\mathbb{Z}_2\times\mathbb{Z}_2$ in Scaling neutrino Majorana mass matrix and baryogenesis via flavored leptogenesis

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We explore the outcomes of a generalized $\mathbb{Z}_2\times\mathbb{Z}_2$ symmetry on a scaling ansatz invariant neutrino Majorana mass matrix. It enables us to determine definite analytical relations between the solar and reactor mixing angles, maximal Dirac CP phase and vanishing Majorana phases. Beside the other testable predictions on the low energy neutrino parameters such as $\beta\beta_{0\nu}$ decay matrix element $|M_{ee}|$ and the light neutrino masses $m_{1,2,3}$, the model also has interesting consequences from the perspective of leptogenesis. With the assumption that the required CP violation for leptogenesis is created by the decay of lightest (N_1) of the heavy Majorana neutrinos, only τ-flavored leptogenesis scenario is found to be allowed in this model. For a normal ordering of light neutrino masses, atmospheric mixing angle is found be less than its maximal value, for the final baryon asymmetry Y_B to be in the observed range. Besides,
an upper and a lower bound on the mass of N_1 have also been estimated. Effect of the heavier neutrinos $N_{2,3}$ on final Y_B has been worked out thereafter. The predictions of this model will be tested in the experiments such as GERDA-II, T2K, NOνA, DUNE etc.

43

Quark mixing in an S3-symmetric 2HDM

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We present a two Higgs doublet model (2HDM) where the smallness of the masses of first generation quarks implies the near block diagonal nature of the CKM matrix and vice-versa. For this set-up, we rely on a 2HDM structure with an S_3 symmetry. We show that an SM-like Higgs emerges naturally from such a construction. Moreover, the ratio of two VEVs, $\tan\beta$ can be precisely determined from the requirement of the near masslessness of the up- and down-quarks.

44

Towards a reconstruction of the lightest squark flavour structure (MSSM with NMFV)

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We investigate the flavour structure of the lightest squark of the MSSM in the framework of non minimal flavour violation. We present two possible ways to gain information on the squark rotation matrix and identify the flavour structure: The first, an idealistic one, is based on direct reconstruction from observables related to squark decay modes. The second one is based on Bayesian statistics together with a previous MCMC study. We implement a comparison of different cases of flavour composition in order to disentangle minimal from non-minimal flavour violation.

45

Detection prospects of light pseudoscalar Higgs boson at the LHC

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The discovery potential of light pseudo scalar Higgs boson for the mass range 10-60 GeV is explored. In the context of the next-to-minimal supersymmetric standard(NMSSM) model, the branching fraction of light pseudo scalar Higgs boson decaying to a pair of photon can be quite large. A pair of light pseudo scalar Higgs boson produced indirectly through the standard model Higgs boson decay yields multiple photons in the final state and the corresponding production rate is restricted by ATLAS data. Discussing the impact of this constraint in the NMSSM, the detection prospects of light pseudoscalar Higgs boson in the channel consisting of at least three photons, a lepton and missing transverse energy are reported. It is observed that the possibilities of finding the pseudoscalar Higgs boson for the above mass range are promising for an integrated luminosity L⊠=100fb−1 with moderate significances, which can reach to more than 5σ for higher luminosity options.

46

Disappearing Track Searches at the LHC and Future Colliders

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For pure wino or Higgsino like dark matter, the mass splitting between the dark matter and the charged component of the dark matter multiplet is quite small and the charged component has rather long lifetime. Thus, we may see them at collider experiments as disappering tracks. Estimating background, we point out that with certain improvement of tracker techniques, most of the region of such dark matters can be covered by future 33 TeV LHC.
The talk is based on 1703.09675 and ongoing works.

52

Status of flavour maximal non-minimal Universal Extra Dimension

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consider an S 1 /Z 2 compactified flat extra dimensional scenario where all standard model states can access the bulk and have generalised brane localised
kinetic terms. The flavour structure of brane kinetic terms for the standard model fermions are dictated by stringent flavour constraints in the first two generations implying a U (2) × U (2) × U (2) flavour symmetry. We consider the constraints on such a scenario arising from precision electroweak data, Higgs physics, dark matter relic density and direct detection measurements. Finally we discuss the possibility of such a scenario in providing an explanation of the recently measured anomaly in R K and R D parameters in flavour physics.

54

New extensions and features in SuperIso Relic

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SuperIso Relic is a public computing program for the calculation of the relic density in supersymmetry (MSSM and NMSSM) as well as flavour observables. We present the extended version of the code which allows the user to calculate the constraints from the latest direct and indirect detection experiment results. Moreover, contrary to most of the existing codes, this new version includes an implementation of the nuclear and astrophysical uncertainties, from namely nuclear form factors, dark matter density and velocity, as well as cosmic ray propagation through the galactic medium, and allows the user, in a straightforward way, to calculate "conservative", "standard" or "stringent" constraints according to the chosen set of uncertainties.

65

Exotics at LHC

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Many theories beyond the Standard Model predict new phenomena accessible by the LHC. The ATLAS, CMS, and LHCb experiments all have rigorous search programs ongoing with the aim to find indications for new physics involving state of the art analysis techniques. This talk reports on new results obtained using the pp collision data sample collected in 2015 and 2016 at the LHC with a centre-of-mass energy of 13 TeV.

66

ATLAS Searches for VH and HH Resonances

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The discovery of a Higgs boson at the Large Hadron Collider (LHC) motivates searches for physics beyond the Standard Model (SM) in channels involving coupling to the Higgs boson. A search for a massive resonance decaying into a standard model Higgs boson (h) and a W or Z boson or two a standard model Higgs bosons is performed. Final states with different number of leptons and where the Higgs decays into a b-quark pair are studied using different jet reconstruction techniques which are complementary in their acceptance for low and high mass transverse momentum. This talk summarizes ATLAS searches for diboson resonances including at least one H bosons in the final state with LHC Run 2 data.

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ATLAS Searches for VV/V+gamma Resonances

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Many extensions to the Standard Model predicts new particles decaying into two bosons (WW, WZ, ZZ, Zgamma) making these important signatures in the search for new physics. Searches for such diboson resonances have been performed in final states with different numbers of leptons, photons and jets where new jet substructure techniques to disentangle the hadronic decay products in highly boosted configuration are being used. This talk summarizes ATLAS searches for diboson resonances with LHC Run 2 data collected in 2015 and 2016.

68

Dark Matter searches with the ATLAS Detector

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The presence of a non-baryonic dark matter component in the Universe is inferred from the observation of its gravitational interaction. If dark matter interacts weakly with the Standard Model it would be produced at the LHC, escaping the detector and leaving a large missing transverse momentum as their signature. The ATLAS detector has developed a broad and systematic search program for dark matter production in LHC collisions. The results of these searches on the first 13 TeV data, their interpretation, and the design and possible evolution of the search program will be presented.

69

Search for heavy resonances decaying to top quarks

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Searches for new resonances that decay either to pairs of top quarks or a top and a b-quark will be presented. The searches are performed with the ATLAS experiment at the LHC using proton-proton collision data collected in 2015 and 2016 with a centre-of-mass energy of 13 TeV. The invariant mass spectrum of hypothetical resonances are examined for local excesses or deficits that are inconsistent with the Standard Model prediction.

70

Search for Higgs decays to beyond the standard model light gauge bosons in four-lepton events with the ATLAS detector at √s = 13 TeV

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Hidden sector or dark sector states appear in many extensions to the Standard Model, to provide a candidate for the dark matter in the Universe or to explain astrophysical observations of positron excesses. A hidden or dark sector can be introduced with an additional U(1)d dark gauge symmetry. We present model-independent searches for dark sector states and interpret the results in benchmark models where the dark gauge symmetry is mediated by a dark vector boson Zd promptly decaying into pairs of same-sign opposite-flavour leptons. The results reported here use the pp collision data sample collected in 2015 and 2016 by the ATLAS detector at the LHC with a centre-of-mass energy of 13 TeV.

71

Search for New Phenomena in Dijet Events with the ATLAS Detector at √s = 13 TeV

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During the last two years the LHC produced pp collisions at the record center-of-mass energy of 13 TeV. The sensitivity of searches for new phenomena with a high mass scale greatly benefited from the energy increase with respect to the LHC run-1 data. Events with two hadronic jets in the final state are of particular interest: new phenomena produced in parton collisions are likely to produce final states with (at least) two partons. In this talk several searches performed by the ATLAS collaboration are presented. The very high mass and the low mass regions have both been investigated, by exploiting dedicated signatures and, in case of the latter, new techniques to overcome trigger limitations. Results and perspectives for these searches will be presented.

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Search for vector-like quarks

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Vector like quarks appear in many theories beyond the Standard Model as a way to cancel the mass divergence for the Higgs boson. The current status of the ATLAS searches for the production of vector like quarks will be reviewed for proton-proton collisions at 13 TeV. This presentation will address the analysis techniques, in particular the selection criteria, the background modeling and the related experimental uncertainties. The phenomenological implications of the obtained results will also be discussed.

73

Searches for new phenomena in final states involving leptons and jets using the ATLAS detector

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Many theories beyond the standard model predict new phenomena which decay to leptons and jets. Searches for new physics models with these signatures are performed using the ATLAS experiment at the LHC. The results reported here use the pp collision data sample collected in 2015 and 2016 by the ATLAS detector at the LHC with a centre-of-mass energy of 13 TeV.

74

Searches for new phenomena in leptonic final states using the ATLAS detector

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Many theories beyond the Standard Model predict new phenomena which decay to well isolated, high-pt leptons. Searches for new physics models with these signatures are performed using the ATLAS experiment at the LHC. The results reported here use the pp collision data sample collected in 2015 and 2016 by the ATLAS detector at the LHC with a centre-of-mass energy of 13 TeV.

75

The darkness within: Unification, and revival of the right

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For all its success, the standard model of particle physics leaves ajar the door for further model building by failing to satisfactorily account for phenomena like parity violation, neutrino mass generation, quantisation of charges, the arbitrariness of hypercharge normalisation, and dark matter, among others. In this talk, we show that it is possible to account for these phenomena along with the ever so desirable but elusive 'one-step' unification in a minimalist version of the left-right symmetric model if one accounts for the dark matter content of the Universe. The model has only one intermediate symmetry breaking threshold at LHC energies and a unification scale testable at Hyper-Kamiokande.

76

Phenomenology of two or more mass-degenerate Higgs bosons in the NMSSM

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The two singlet like Higgs bosons (a scalar-pseudoscalar pair) in the Next-to-Minimal Supersymmetric Standard Model (NMSSM), can result in important phenomenological aspects at the Large Hadron Collider (LHC), which may help to probe the non-minimal features of supersymmetry. There exist possibilities that anyone of the scalar-pseudoscalar pair could be almost mass-degenerate with the 125 GeV SM-like Higgs boson. In the real NMSSM, when the mass difference between two Higgs states is comparable to their individual total decay widths, the quantum mechanical interference due to the relevant diagonal as well as off-diagonal terms in the propagator matrix between them can become sizeable. This possibility invalidates the usage of both the narrow width approximation (NWA) and the single Breit-Wigner (BW) approach to compute the cross section for the production of a di-photon pair with a given invariant mass via resonant Higgs bosons in the gluon-gluon fusion. Motivated by the baryon asymmetry of the universe, we explicitly invoke CP-violating phases in the Higgs sector of the NMSSM. As a consequence, all the Higgs interaction eigenstates mix to give five neutral CP-indefinite physical mass eigenstates. In this scenario, the interference effects due to the off-diagonal terms in the Higgs mass matrix that mix the pseudoscalar states with the scalar ones can also become significant, when these two are sufficiently mass-degenerate, challenging both the NWA and the approach based on the tree-level interference, and eventually considerably modifying the phenomenology of the observed Higgs boson at the LHC. We perform a detailed analysis, in both the real and complex NMSSM, of these interference effects, when the full propagator matrix is taken into account, in the production of a photon pair with an invariant mass near 125 GeV through gluon-gluon fusion. It is observed that these effects can account for up to ~ 40% of the total cross section for certain region of model parameter space. We also investigate how such mutually interfering states contributing to the 125 GeV signal observed at the LHC can be distinguished from a single BW resonance.

We have also studied the possibility and effects of two or more mass degenerate Higgs states on the heavier side of the NMSSM Higgs mass spectrum. We have investigated the scope of distinguishing these heavy Higgs bosons at the current and future experimental facilities at the LHC in few prominent channels like the di-photon, di-tau and bbar, produced through the decay of resonant heavy Higgs bosons in the gluon-gluon fusion. We have investigated the interference effects between two or more nearly mass-degenerate heavier Higgs states to explore the possibility of identifying them from what might appear as a single BW resonance produced in gluon-gluon fusion and decaying in the di-photon, di-tau and bbar channels, at the current and future experimental setups at the LHC.

77

Annihilation of dark matter particles to produce Higgs

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Considering the relationship between the decay width of Higgs decaying into two gluons and the area of cross section for the two gluon fusion, the area of cross section for the annihilation of two dark matter particles to produce Higgs can be calculated. The general formula for the energy radiated in the annihilation of n(2,3,…,n) dark matter particles having equal masses to produce Higgs have been calculated. The expression for the coupling constant of dark matter particles when n(2,3,…,n) dark matter particles having equal masses annihilate to produce Higgs can also be calculated from the general formula of the energy radiated.

79

Self Organized Higgs Criticality

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The critical point for a Higgs model can be associated with a minimum in the potential for a modulus field so that classical dynamics of the modulus set the Higgs mass to zero. Quantum fluctuations of the modulus give rise to a non-vanishing but suppressed vacuum expectation value for the Higgs, breaking symmetries spontaneously. An explicit 5D model for this type of Higgs sector is constructed.

80

Recent results from SuperCDMS Soudan and plans for SperCDMS SNOLAB

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The Cryogenic Dark Matter Search (CDMS) and its successor SuperCDMS experiment at Soudan have provided world-leading, low-threshold, low-background dark matter search results using cryogenically cooled semiconductor detectors. The next generation (G2) SuperCDMS experiment at SNOLAB is designed to provide world-leading sensitivity to low-mass WIMP recoil using a combination of iZIP detectors with discrimination and high voltage (HV) detectors without discrimination. The phonon mediated high voltage detectors give up discrimination but achieve much lower thresholds through Luke-Neganov amplification of the low ionization signal expected from WIMP nuclear recoils. I will present recent results from the SuperCDMS Soudan experiment as well as status and plans for the SuperCDMS SNOLAB experiment.

81

Reconstructing a light pseudoscalar in the Type-X 2HDM

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I will discuss the detectability as well as reconstructibility of a light pseudoscalar particle A, of mass in the 50 - 60 GeV range, which is still allowed in a Type-X (lepton-specific) two-Higgs doublet scenario. The light pseudoscalar in the aforementioned range, helpful in explaining the muon anomalous magnetic moment, has not only substantial branching ratio in the tau+ tau- channel but also one of about 0.35\% in the mu+ mu- final state. I will show how to faithfully reconstruct the A mass using the mu+ mu- mode, and establish the existence of a pseudoscalar around 50-60 GeV. This is the most reliable way of econstructing the light pseudoscalar mass, with a statistical significance that amounts to discovery, with a few hundred (or less) fb^{-1} of integrated luminosity.

82

Minimal unified resolution to B anomalies with lepton mixing

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It is a challenging task to explain, in terms of a simple and compelling new physics scenario, the intriguing discrepancies between the standard model expectations and the data for the neutral-current observables R_K and R_{K^*}, as well as the charged-current observables $R(D)$ and $R(D^*)$. We show that this can be achieved in an effective theory with only two unknown parameters. In addition, this class of models predicts some interesting signatures in the context of both B decays as well as high-energy collisions.

83

Pinning down Anomalous $WW\gamma$ Couplings at the LHC

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Precision measurements of triple gauge boson couplings are an important source of indirect information about the presence of new physics at energy scales which are not directly accessible at accelerators. The production of $W\gamma$ pairs at the LHC can be used very effectively to set constraints on the anomalous couplings, generally parametrized as $\Delta\kappa_\gamma$ and λ_γ. A comprehensive study is made of this process, with a comparative estimate of the efficiency of different kinematic variables in constraining the different anomalous couplings.

84

Next-to-minimal dark matter at the LHC

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Many UV completions of the SM predict a dark matter candidate that is a mixture of a singlet and SU(2) n-plet fields (e.g. doublets and triplets arise naturally in SUSY). Moreover the "minimal dark matter" requirements currently predicts an SU(2) 5-plet as the only viable fermionic candidate for dark matter and sets the mass at ~10 TeV, well outside the reach of any current experiment. We extend this minimal idea to "next-to-minimal dark matter" models which are comprised of a singlet and a SU(2) n-plet where n = 3, 4 or 5; mixing and interactions with SM are modelled using EFT operators. For these models, it is possible to obtain the correct relic density even in mass range 100-300 GeV while evading current direct detection bounds. We find in particular, for the well-tempered 5-plet model, the most sensitive search in this mass range is via colliders. The small mass gap between the charged partners of the DM lead to long-lived particles at the LHC, providing a virtually background-free search channel for such scenarios. We comment on the current bounds and future reach of the LHC for such well-tempered models.

88

Heavy-Lifting of Gauge Theories by Cosmic Inflation

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Future measurements of primordial non-Gaussianity (NG) can reveal cosmologically produced particles with masses of order the inflationary Hubble scale, which can be as high as ~ 10^14 GeV. I will describe how (partially) Higgsed gauge theories, naturally having particles with Hubble scale masses, can leave observable signatures in future NG measurements giving us a chance to do spectroscopy of masses and spins of such particles. In particular, a "heavy-lifting" mechanism will be analyzed in which couplings to curvature can result in Higgs scales of order the Hubble scale during inflation while reducing to far lower scales in the current era, where they may now be accessible to collider and other laboratory experiments. Such a mechanism is testable in the sense that renormalization-group running of terrestrial measurements can yield predictions for cosmological NG.

90

On the Validity of the Effective Potential and the Precision of Higgs Self Couplings

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An interesting New Physics scenario that can be linked to a large Higgs self coupling is the baryogenesis based on the strong first order phase transition. We revisit the strong first order phase transition in two classes of Beyond the Standard Models, namely the Higgs portal with the singlet scalar with the Z2 symmetry and the effective field theory approach with higher-dimensional operators. We investigate a few important issues in the validity of the effective potential, caused by the breakdown of the high-temperature approximation, and in the criteria for the strong first order phase transition. We illustrate that these issues can lead to O(1) uncertainties in the precision of the Higgs self couplings, which are relevant when discussing sensitivity limits of different future colliders. We show that the correlation between the Higgs trilinear coupling and the quartic coupling will be useful for differentiating various underlying New Physics scenarios and discuss its prospect for the future colliders

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Dark Matter as a remnant of SQCD Inflation

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We propose a strongly coupled supersymmetric gauge theory that can accommodate both the inflation (in the form of generalized hybrid inflation) and dark matter (DM).In this set-up, we identify the DM as the Goldstones associated with the breaking of a global symmetry (SU(4) × SU(4) ⟶ SU(4)) after inflation ends. Due to the non-abelian
nature of this symmetry, the scenario provides with multiple DMs. We then construct a low energy theory which generates a Higgs portal like coupling of the DMs with Standard Model (SM), thus allowing them to thermally freeze out. While the scales involved in
the inflation either have a dynamical origin or related to UV interpretation in terms of a heavy quark field in the supersymmetric QCD (SQCD) sector, the DM masses however are generated from explicit breaking of the chiral symmetry of the SQCD sector. We
discuss DM phenomenology for both degenerate and non-degenerate cases, poised with DM-DM interactions and find allowed region of parameter space in terms of relic density and direct search constraints.

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Sterile neutrinos as SIMP dark matter

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Self-interactions among dark matter particles can ameliorate the small scale structure problems of the standard cold dark matter scenario. Motivated by this fact, we consider for the first time the production of Majorana fermions as strongly-interacting-massive-particle dark matter. We show that the relic abundance is determined by d-wave suppressed 4 -> 2 annihilations within the Majorana fermions, and we determine the parameters of the model that lead to the observed dark matter abundance. We also discuss the implications for sterile neutrino dark matter.

93

New avenues for testing Lepton Flavor Universality in B decays

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With the huge data available from the Large Hadron Collider and Belle II expected to start soon Flavor Physics sector has become a favorable ground to look for Physics beyond the Standard Model (SM). Unfortunately, there is no indication of anything new at the Energy Frontier. In recent times the Flavor sector has seen some deviations in the form of puzzles in R_D and R_D*, which appear to be slightly different from the SM expectations. The results from BABAR and BELLE including that of the LHCb pointed us some mismatch in the very well tested Lepton Flavor Universality. In this analysis we will use the results of R_D and R_D* and constrain the parameter space and explore other observables to look for any such deviation. We will use decays modes $B_c \to J/\psi l \nu$ and other $b\to c l \nu$ decays to draw our conclusions, where we will also test the scenario of Leptoquarks as the probable cause of any discrepancy between theory and data.

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Singlet scalar Dark matter in U(1)_{B-L} models without right-handed neutrinos

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We investigate the phenomenology of a singlet scalar dark matter in a simple $B-L$ gauge extension of the Standard Model where the dark matter particle is charged under the $U(1)_{B-L}$ symmetry. The non-trivial gauge anomalies are canceled with the introduction of three exotic fermions with $B-L$ charges as $-4,-4,5$, instead of right-handed neutrinos $\nu_{Ri},i=1,2,3$ with $B-L=-1$ in conventional $U(1)_{B-L}$ model. Without the need of any ad-hoc discrete symmetry, the $B-L$ charge plays a crucial role in stabilizing the dark matter. The dark matter phenomenology is governed mostly by $Z^\prime$-portal
and partly with Higgs portal. The relic abundance is dominated by $Z^\prime$ mediated annihilation channels
while the direct detection cross section gets contributions from $Z^\prime$ as well as Higgs mediated processes.
We show the allowed parameter space consistent with PLANCK data (for relic density), direct detection experiments like LUX, XENON100 and XENON1T as well as satisfying Collider bound. Finally we comment on
semi-annihilation of dark matter and relic density for particular choice of $B-L$ charge.

95

Mass generation from a non-perturbation technique

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The concept of mass generation for a higher form field in an emergent gravity theory underlying a geometric torsion in second order formulation is explored. It is shown that a massless KR-field 2-form quanta underlying a U (1) dynamics on a D4-Brane becomes massive NS-field quanta in the spontaneous symmetry breaking phase on a fat D4-brane at the expense of a non-perturbative dynamical correction.

98

LHC signals of vector-like down-type quarks in a U(1) extension of SM.

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Co-Authors: Prof. LI, Tianjun [2]; Prof. NANDI, Satyanarayan [3]; Dr. RAI, Santosh Kumar [1]

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In this talk I will discuss about our recent work where we have considered the pair production of vector-like down type quarks in a E6 motivated U(1) extension of SM, where each of the produced down-type vector-like quark decays into a SM quark and a SM singlet scalar. Both the vector-like quark and the singlet appear naturally in the E6 model with masses at the TeV scale with a favorable choice of symmetry breaking pattern. We have focused on the non-standard decay of the vector-like quark and the new scalar which decays to two photons or to two gluons. We have analyzed the signal for the vector-like quark production in the channel with two photon and atleast two jet final state, and shown how the scalar and vector-like quark masses can be determined at the LHC.

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Dark matter assisted Dirac leptogenesis and neutrino mass

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The nature of neutrino, Dirac or Majorana, is yet to be confirmed. In this talk we assume that neutrinos are Dirac and study its consequences to matter antimatter asymmetry as well as dark matter content of the Universe.

101

Jet substructure shedding light on heavy Majorana neutrinos at the LHC

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The existence of tiny neutrino masses and flavor mixings can be explained naturally in various seesaw models, many of which typically having additional Majorana type SM gauge singlet right handed neutrinos. If they are at around the electroweak scale and furnished with sizeable mixings with light active neutrinos, they can be produced at high energy colliders, such as the Large Hadron Collider. A characteristic signature would be same sign lepton pairs, violating lepton number, together with light jets. We propose a new search strategy utilising jet substructure techniques, observing that for a heavy right handed neutrino mass much above W-mass, the two jets coming out of the boosted W-boson may be interpreted as a single fat-jet. Hence, we look for such fat-jet associated with lepton pair to explore intermediate to heavy mass region at the 13 TeV LHC.

102

Resolving R_K and $R_{K^\ast}$ anomalies via R-parity violating interaction

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Co-Authors: Dr. DAS, Diganta [2]; Dr. HATI, Chandan [3]; Dr. MAHAJAN, Namit [4]

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The LHCb collaboration has measured lepton flavor universality (LFU) observables (R_K and $R_{K^\ast}$) in semileptonic B decays recently. These measurements hint towards the breaking of lepton universality, a well tested feature built into the Standard Model. In this work we revisit the framework of R-parity violating supersymmetry to explore the possibility of explaining these anomalies. We show that RPV interactions allow new contributions to $b \to s \mu \mu$ transition which can explain the experimental values while satisfying the stringent bounds coming from low-energy flavor data.

103

Prospects for new physics in flavor violating τ decays at current and future colliders

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The discovery of lepton flavour violating interactions will be striking evidence for physics beyond the Standard Model. We focus on the flavor violating decays of τ and evaluate the discovery potential of current and future high-energy colliders to probe lepton flavour violation in the τ sector. Based on this potential we determine the expected constraints on parameters of new physics in the context of the Type-II Seesaw Model, the Left-Right Symmetric Model, and the Minimal Supersymmetric Standard Model. The existing and ongoing 13 TeV run of the Large Hadron Collider has the potential to produce constraints that outperform the existing e+e− collider limits for certain decay modes.

104

Symmetries of maximal supergravity in the light-cone gauge

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The maximally supersymmetric extension of Einstein gravity in four dimensions is N = 8 supergravity, which also exhibits an exceptional symmetry. I will outline how both the maximal supersymmetry and the exceptional symmetry may be used to construct the Hamiltonian of the theory using the light-cone gauge. I will show that the d = 4 theory may be lifted to its parent theory, N = 1 supergravity in eleven dimensions, by choosing to preserve one of these two symmetries.

105

Searches for heavy resonances decaying into Z, W and Higgs bosons at CMS

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A summary of the searches for heavy resonances (~1 TeV scale) decaying in dibosons is presented, performed on data produced by LHC p-p collisions at $\sqrt{s}$ = 13 TeV and collected with the CMS detector during 2016. The common feature of these analyses is the boosted topology, namely the decay products of the considered bosons (both electroweak (W, Z) bosons and the Higgs boson) are expected to be highly energetic and close in angle, leading to a non-trivial identification of the particles involved in the final state (quarks, leptons, neutrinos). The exploitation of jet substructure techniques allows to increase the sensitivity of the searches where at least one boson decays hadronically. Various background estimation techniques are adopted, based on data-MC hybrid approaches or relying only in control regions in data. Results are interpreted in the context of the Warped Extra Dimension and Heavy Vector Triplet theoretical models, two possible scenarios beyond the standard model.

106

Parameter space of `fat-brane' UED model after ATLAS di-photon and multi-jet searches at 13 TeV LHC

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In the fat-brane realization of Universal Extra Dimensions (UED) models the gravity mediated decays of Kaluza-Kelin (KK) particles offer interesting collider signals. Depending on the parameter space of the model, decays of level-1 KK particles can give rise to gamma gamma and/or multi-jet plus missing transverse momenta signals. We analyzed the parameter space of `fat-brane' scenarios in UED in the light of ATLAS gamma gamma plus missing transverse momenta and multi-jet plus missing transverse energy searches at the LHC with 13 TeV center-of-mass energy with 3.2 and 36.1 inverse femto-barn integrated luminosities, correspondingly.

107

Phenomenological Implication of Non-holomorphic Soft SUSY Breaking Interactions

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It is known that in the absence of a gauge singlet field, a specific class of non-holomorphic (NH) interactions can be considered as soft SUSY breaking in nature. An extension of the phenomenological Minimal Supersymmetric Standard Model (MSSM) with NH terms that accepts all the input parameters at the electroweak scale shows various promising features. These include a possibility of a strong reduction in electroweak fine-tuning even for heavy higgsinos. A large SUSY contribution to muon $g - 2$ is possible even for a significantly small $\tan\beta$ and large values smuon mass. The Higgs mass radiative corrections are contributed by both the holomorphic and NH trilinear soft parameters A_t and A_t', thus diluting the requirement to have a larger A_t. The model also provides with valid parameter space satisfying the $b\rightarrow s \gamma$ for a large $\tan\beta$ which would otherwise be unavailable in pMSSM. Since a hidden sector F-type SUSY breaking model with two chiral superfields shows Planck mass suppression of the NH terms, the work is further extended to minimal Gauge Mediated SUSY breaking (mGMSB) that has a low scale for SUSY breaking. Promising features can, however, be seen only with matter-messenger interaction scenarios, which is not pursued in the study.
(Based on arXiv:1604.06367 and arXiv:1710.10120)

108

Attacking QCD uncertainties in Monte Carlo event generators for gamma-ray dark matter searches

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We discuss QCD uncertainties in the modelling of the gamma-ray energy spectra from Dark-Matter (DM) annihilation in the galaxy region and beyond.
Dark Matter particles, being neutral, cannot couple directly to photons.
Photons are instead produced as the result of the fragmentation and decay of the particles the DM annihilates into.
In phenomenological studies the photons energy spectra are typically computed using Monte Carlo event generators.
These results have however intrinsic uncertainties due to the specific model used and the choice in model parameters, which are difficult to asses and which are typically neglected.
We derive a new set of hadronisation parameters (tune) for the Pythia8 Monte Carlo generator from a fit to LEP data at the Z peak.
For the first time we derive a conservative set of uncertainties on the shower and hadronisation model parameters.
Their impact on the gamma-ray energy spectra from DM annihilation into different SM particles is evaluated and their impact on DM interpretations of the galactic center excess observed by FERMI-LAT is discussed.
The spectra and their uncertainties are provided in tabulated form for future use.

Parallel Session: Flavour Physics (FP) / 109

Study of Flavour Changing Neutral Current(FCNC) interaction via Single Top quark production at LHeC.

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Unlike top quark pair production, single top quark production occurs via the electroweak interaction. One consequence of this is that the process allows us to make unique measurement of the Cabibbo-Kobayashi-Maskawa mixing matrix parameter $|V_{tb}|$. Within Standard Model (SM) this is the only observed particle which decays weakly, without any QCD effect i.e., into a real W-boson and a b-quark with $Br(t\to Wb\simeq 1)$, within unitarity constraints. Many Beyond SM scenarios sets constraints on Flavour Changing Neutral Current(FCNC) interaction of top quark by relaxing the unitarity constraints. A phenomenological study has been done for FCNC interaction via the tqZ-coupling vertex in its production channel at proposed Large Hadron Electron Collider(LHeC). We have also make a detail study of its spin information which remain unpurtabed after decay, due to absence of QCD effect. Thus makes it more special for analysing the spin dynamics of a bare quark at modern colliders.

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Missing Energy Signals in $t\bar{t}$ Production as a Probe of Large Extra Dimensions at an e^+e^- Collider

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The discovery of a light Higgs boson has made the hierarchy problem in the Standard Model of electroweak interactions more immediate. Among the new physics solutions proposed for this is a model with large extra dimensions, which, among other things, predicts a tower of invisible, massive graviton Kaluza-Klein (KK) modes, leading to characteristic missing energy-momentum signals at a collider. We have studied production of graviton KK modes in association with $t\bar{t}$ pairs at high energy $e^+ e^-$ colliders. Preliminary studies show that the missing energy component in these signals could help us probe significantly higher values of the string scale M_S that have been achieved till now.

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Searches for long-lived particles and other non-conventional signatures

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Many extensions of the standard model including SUSY predict new particles with long lifetimes, such that the position of their decay is measurably displaced from their production vertex, and particles giving rise to other non-conventional signatures. We present recent results of searches for long-lived particles and other non-conventional signatures obtained using data recorded by the CMS experiment at Run-II of the LHC.

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Search for Sterile Neutrino and NSI through CNS with the MINER Experiment

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Mitchell Institute Neutrino Experiment at Reactor (MINER) is an exciting new experiment being commissioned at the TAMU TRIGA nuclear reactor with more than 60 collaborators from 4 countries. MINER has sensitivity to be the most sensitive experiment to detect coherent scattering of weakly interacting neutrinos on our detectors, the same coherent scattering process that governs dark matter scattering on our detectors, with same low threshold challenges. Such precision measurements may hold the key to discover “New Physics” beyond the Standard Model, such as what is the nature of dark matter, is there a 4th generation of neutrino, do neutrinos have non-Standard Model interactions, are they their own anti-particles. The detector technology leverages the existing cryogenic detector technology developed for the SuperCDMS experiment.

113

Predictive 2HDM as a low energy effective theory

Dr. SAHA, Ipsita [1]; Prof. BHATTACHARYYA, Gautam [2]; Dr. PEREZ, M. Jay [3]; Dr. DAS, Dipankar [3]; Prof. SANTAMARIA, Arcadi [3]; Prof. VIVES, Oscar [3]

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Two-Higgs-doublet models (2HDM), {\em per se}, cannot predict the values of the nonstandard scalar masses (m_H, m_A and m_+). However, assuming that a type-II 2HDM arises as an electroweak scale effective theory from a supersymmetric ultraviolet (UV) completion, where the quartic couplings of the 2HDM potential are related to the gauge couplings of the Standard Model (SM), the ever growing LHC Higgs boson data allow the {\em hitherto} unknown nonstandard scalar masses to be almost uniquely determined from just two input parameters: the supersymmetry breaking scale and $\tan\beta$ (the ratio of the two vacuum expectation values). We highlight some of the salient features of this framework not emphasized previously in the context of the Minimal Supersymmetric Standard Model (MSSM), and make specific predictions on the masses and branching ratios of the nonstandard scalars which can be probed by targeted experimental searches. Our framework is valid even if the UV theory is not supersymmetric, applying to any theory which unambiguously predicts the scalar quartic couplings at the high scale.

114

Interacting ultraviolet fixed points of supersymmetric gauge theories

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We discuss recent developments in extending the understanding of gauge theories which posess interacting ultraviolet fixed points to the case where theories are supersymmetric. We outline how perturbation theory allows us to reliably demonstrate the existence of such fixed points, as well as how we may use the tools of supersymmetry to explore features of such models beyond perturbation theory.

115

Extranatural inflation, CMB observations and Weak Gravity Conjecture

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It is important to understand not only the observational constraints on large field inflation, but also any possible theoretical constraints. Among the theoretical constraints, one could focus one's attention to UV sensitivity and on consistency with Weak Gravity Conjecture. In this talk, I shall present simple variations of the minimal extranatural inflation model of inflation which are completely consistent with CMB observations, have potentials protected from unknown UV effects and are consistent with Weak Gravity Conjecture.

117

PeV scale Supersymmetry breaking and the IceCube neutrino flux

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The observation of very high energy neutrino events at IceCube has grasped a lot of attention in the fields of both astrophysics and particle physics. It has been speculated that these high energy neutrinos might originate either from purely conventional astrophysical sources or from the late decay of a super heavy (PeV scale) dark matter (DM) particle. In order for decaying DM to be a dominant source of the IceCube high-energy neutrinos, it would require an unusually suppressed value of coupling of DM to neutrinos. In this talk, I will explain about the possible origin of this small coupling in the context of a minimal supergravity model which conserves R-parity and also includes right handed neutrino superfields. With the main assumption of super-partner masses at the PeV scale, we have found in this model several natural order-of-magnitude ``miracles'', (i) the gravitino is produced via freeze-in as a DM candidate with the correct relic density (ii) the right-handed (RH) sneutrino makes up only a tiny fraction (10^{-5}), of the present day density of the universe, yet its decay lifetime to the gravitino and neutrinos is such that it naturally predicts the right order-of-magnitude for the IceCube neutrino flux. This model also predicts a flux of 100 TeV gamma rays from the decaying RH sneutrino which are within the current observational constraints but could potentially be detected in the future by observatories such as the Cerenkov Telescope Array.

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KK Higgs produced in association with a top quark pair in the bulk RS Model

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Top quark plays an important role in many beyond standard model (BSM) scenarios. This is because BSM theories predict massive excitations that have enhanced coupling to top quarks. This makes top quarks prime candidates for search of massive excitations at the Large Hadron Collider (LHC). Such a massive excitation when produced in association with a top quark pair would result into a final state characterised by four top quarks. Two out of the four top quarks which will be decay products of the massive excitation will be comparatively more boosted. This makes the search for such a process exciting taking into consideration very small cross section of four top quark final state in Standard Model (SM) which will be a background for this process.

We present a search strategy within bulk Randall-Sundrum Model for the first KK mode of the Higgs boson produced in association with a top quark pair.

119

R_D^(*)-anomaly: A model-independent collider signature and possible hint for R -parity violating supersymmetry

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We show that the R_D^(*) anomaly necessarily implies (by crossing symmetry) model-independent collider signals of the form pp --> b\tau \nu that should be searched for at ATLAS/CMS as a complementary test of the anomaly. Next we suggest a possible interconnection of the anomaly with the radiative stability of the Standard Model Higgs boson and point to a minimal effective supersymmetric scenario with R-parity violation as the underlying cause. We also comment on the possibility of simultaneously explaining the recently reported R_K^(*) anomaly in this setup.

120

Measurement of the SM Higgs boson mass in the diphoton and 4l decay channels using the ATLAS detector

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One of the fundamental properties of the Higgs boson, its mass, is measured by way of studying the invariant mass of the 4l and diphoton decay channels with about 36fb-1 of data collected by the ATLAS experiments. Since in this channel the final state can be reconstructed as an invariant mass peak with a good experimental resolution this measurement can be done in a model independent way and used as an input to compare other measurement properties with the SM predictions.

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Measurement of the Higgs boson cross sections and properties in the diphoton, ZZ and WW decay channels using the ATLAS detector

Dr. MARCO, Sessa [1]

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The latest results on the measurement of the Higgs boson cross sections and properties in the diphoton, ZZ and WW decay channels with the ATLAS detector are presented, using about 36 fb-1 of pp collision data collected at 13 TeV.

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Measurement of the Higgs boson cross sections and properties using the bb, tautau and mumu decay channels with the ATLAS detector

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The latest results on the measurement of the cross sections and properties of the Higgs boson in the fermionic decay channels to bb, tautau and mumu with the ATLAS detector are presented, using about 36 fb-1 of pp collision data collected at 13 TeV.

123

Search for the SM Higgs boson in the ttH production channel using the ATLAS detector

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The associated production of the Higgs boson with top quarks should allow the direct observation of the coupling of the Higgs boson to top quarks. The channel also benefits from a large cross-section increase between 8 and 13 TeV. ATLAS results in the search for the Higgs boson in the ttH production mode based on about 36fb-1 collected data will be presented.

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Search for high mass bosonic resonances with the ATLAS detector

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[1] *Annecy LAPP*

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Several theories beyond the Standard Model, like the EWS or 2HDM models, predict the existence of high mass Higgs particles, which could decay into final states with Weak bosons. In this presentation the latest ATLAS results on these searches will be discussed, using about 36 fb-1 of p-p collisions at 13 TeV.

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Search of a high mass neutral Higgs boson in fermion final states with the ATLAS detector

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Several theories, like the Minimal Supersymmetric Standard Model, predict a high mass neutral Higgs boson with a significant decay rate into the bb, mu-mu or tau-tau final states. The search for a scalar resonance in fermion decay channels is presented, using about 36 fb-1 of p-p collisions at 13 TeV.

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Charged Higgs boson searches with the ATLAS detector

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Several theories beyond the Standard Model, like the 2HDM, predict the existence of high mass charged Higgs particles. Such charged Higgs, produced in association with a top quark or in VBF, are searched for in several decay channels, using about 36 fb-1 of p-p collisions at 13 TeV.

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Search for di-Higgs production with the ATLAS detector

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An enhanced production of two Higgs bosons would be a clear sign of beyond Standard Model physics. A search is performed for resonant and non-resonant excess production, including several decay channels of the two Higgs bosons. The analysis uses about 36 fb-1 of p-p collisions at 13 TeV.

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Search for non-standard, rare or invisible decays of the Higgs boson with the ATLAS detector

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Some theories predict Lepton Flavour Violating decays of the Higgs boson, while other predict enhanced decay rates in rare modes like Z-photon, J/Psi-photon and Phi-photon or into invisible particles. The next to MSSM theory predicts the existence of a light pseudoscalar boson "a", and the decay of the Higgs boson into a pair of such particles. Such non-standard, rare or invisible decay modes are searched for using about 36 fb-1 of p-p collisions at 13 TeV.

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Latest Result on B-physics from ATLAS

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ATLAS has a wide programme of activities in B-physics. The results of studies in the electroweak sector and beyond SM searches will be discussed, including CP violation and mixing in the B0_s and B0 systems, rare decay of B0_(s) to muon pairs, and angular correlations in the decay of B0 to K*0 mu+mu-.

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ATLAS Top quark results

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The top quark is the heaviest known fundamental particle. As it is the only quark that decays before it hadronizes, this gives us the unique opportunity to probe the properties of bare quarks at the Large Hadron Collider. This talk will present highlights of a few recent precision measurements by the ATLAS Collaboration of the top quark using 13 TeV and 8 TeV collision data: top-quark pair and single top production cross sections including differential distributions will be presented alongside top quark properties measurements. These measurements, including results using boosted top quarks, probe our understanding of top quark production in the TeV regime and can be used to set limits on new physics models. Measurements of the top quark mass and searches for rare top quark decays are also presented.

131

Lighting up Einstein's Dark Universe

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It is now an exceptional time for modern cosmology, when we can observe the universe with high precision and connect cosmological measurements with theory. The excitement about the advances of observational cosmology is accompanied by the awareness that we face some major challenges: we still lack compelling theoretical models for dark matter, (that accounts for the formation of the structure we see around us) , and dark energy, that drives cosmic acceleration, as well as a deeper understanding of the mechanism that set up primordial conditions, and these puzzles have deep roots in particle theory and gravity.

I will focus on the challenge posed by cosmic acceleration, review approaches to it and discuss theoretical issues involved in finding an optimal framework to test gravity and the physics of dark energy from upcoming high precision measurements of large scale structure.

132

MSSM Higgs Boson Production: Gluon Fusion

Author: SPIRA, Michael [1]

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The recent discovery of the Higgs boson at the LHC marked the completion of the Standard Model of strong and electroweak interactions. However, several problems of the Standard Model require extensions to BSM models. A prime example of those extensions is the minimal supersymmetric Standard Model (MSSM). This talk will address the full NLO corrections to the gluon-fusion mechanism for the production of scalar MSSM Higgs boson. This requires the numerical integration of the corresponding two-loop integrals supplemented by end-point subtractions and stabilization strategies for the virtual threshold effects. The final results are embedded in the framework of effective bottom-Yukawa couplings thus analyzing the validity of the widely-used 'Delta_b' approximation.

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Model building with asymptotic safety

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We discuss the approach to building BSM models based on the idea that gauge couplings may reach a non-trivial fixed point in the UV, including possible collider signatures such as R-hadrons, diboson signatures, and modification to SM running.